Assessing Materials Vendor Selection in Construction Project Supply Chain: The Relative Importance Index Approach

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ABSTRACT

By selecting the right material vendor, the risk of project failure, delays, stakeholder disputes, and budget-overrun can be avoided. However, little is known of the preferred construction vendor selection criteria and the priority placed on them by construction project managers. To fill this gap, this study explored the specific criteria used in selecting construction project vendors and determined the relative importance placed on the selection criteria. Primary data were collected using the structured questionnaire from 71 randomly-selected on-site construction project managers and engineers. Data analysis was carried out using weighted mean scores. They were then ranked according to their priority using the Relative Importance Index (RII). The results reveals that 22 criteria, grouped into four dimensions: capability, quality, costs, and sustainability were the most important criteria for selecting construction project vendors. In practice, these result implies that supplier capacity, supplier quality, supplier costs, and supplier sustainability selection variables are important sources of effective construction project management. This study adds value to existing knowledge because the selection of construction project suppliers can now be achieved by utilizing the relative importance index approach as demonstrated in this paper.

KEYWORDS: Construction project management; Relative importance index; Construction supply chain management; Sustainable vendor selection; supplier selection.

INTRODUCTION

Infrastructural projects such as the construction of roads, railways, electrical energy dam, overhead bridges, shopping malls, and housing estate amongst others are vital for the development of any nation. To a large extent, infrastructure represents an aspect of the physical evidence through which the socio-economic growth of a nation can be measured (Hanachor, 2012; National Bureau of Statistics, 2015). In reality, government performance is usually linked amongst other factors to the quality of infrastructural projects they successfully execute and maintained in a period of an administration. In addition, the number of infrastructure available for use by the citizens is an important building block that support national growth and development (Adebowale & Ayodeji, 2015; Hanachor, 2012), and the ease of doing business in any area is closely associated with available and functional infrastructure.

In many other developing nations, the management of construction project has not been very positive given the spate of construction failures in many cities and metropolitan centres (Aibinu

& Odeyinka, 2006; Damoah & Kumi, 2018; Eja & Ramegowda, 2020; Nweze, 2016). In Nigeria for instance, the historical antecedents of construction projects and their management has not been very impressive (Odeyemi, Giwa, & Abdulwahab, 2019). Ample evidences of collapsed building, abandoned projects, delayed project delivery, ill-maintained infrastructure, and poor quality of construction projects litter many cities in the country. Moreover, issues bordering on time and budget overrun, client dissatisfaction, socio-environmental injuries, and unresolved host community disputes are also intricately linked to many construction project failures in Nigeria (Akande et al., 2018; Nweze, 2016; Somya & Namratha, 2021).

Doubtless, suggestions have been made on how to strengthen the performance of construction projects which Adebowale and Ayodeji (2015) defines as the project ability to fulfilling stakeholder requirements, meeting users and project team needs, achieving pre-stated objective, and delivering within budget and time. For instance, Zuofa and Ochieng (2014) advocates involving only trained project management professionals, instituting stiffer punitive actions on corrupt and unethical practices, and improved project management training. Jenner (2015) suggest the adoption of a portfolio approach that treats projects and programs as investments with relevant performance indicators and expectations. Botlhale (2017) suggests proper monitoring, construction supervision and enforcement and increased responsibility for construction performance.

Notwithstanding the suggestions, it appears that project supply chain managers are yet to come to terms with how the selection of construction materials vendors could influence project management outcomes. In addition, the construction supply chain literature shows very little presence of studies that evaluate the relative importance of the selection criteria across the different stakeholders in construction industry. Thus, this study attempt to provide valuable insight into the specific criteria used in selecting construction project vendors and to determine the relative importance placed by construction project managers on the vendor selection criterion.

Vendor selection is an important process in project materials supply chain management both in public and in private sector. Its influence on the success of infrastructure development and performance is huge. Vendor selection is the process by which suppliers are reviewed, evaluated and chosen to become part of the company's supply chain. Selecting a project material vendor basically involves scanning, analyzing, examining and filtering the basic background data of a pool of vendors with the aim of choosing one that will enhance the achievement of the project's performance (Solon, 2015). Consequently, an insight into the criteria employed for the selection of project materials vendors in the Nigerian construction supply chain is very important.

Knowledge of the specific criteria often employed by construction project managers in selecting their vendors would help in benchmarking such practices with global project supplier selection standards. This would assist in policy adjustments for the Nigerian construction project management industry. An insight into the relative importance of the identified selection criteria used by the practitioners would help in ranking or prioritizing the criteria, and constructing the relative importance index that could become a yardstick for gauging supplier selection performance in the Nigerian project management industry. This would serve as a guiding framework for project managers in selecting the right materials vendors, and possibly reducing the failure rate of construction projects in Nigeria.

RESEARCH OBJECTIVES

The specific objectives of this study are two-folds, namely:

i. Identifying the specific criteria often employed in the selection of construction project suppliers
ii. Assessing the relative importance of the supplier selection criteria to the construction project managers

RESEARCH QUESTIONS

This study provides answers to two specific research questions:

iii. What are the specific criteria often employed in the selection of construction project suppliers?
iv. What is the relative importance of the supplier selection criteria to the construction project managers?

LITERATURE REVIEW

Vendor selection process in the construction industry

For construction project managers, the vendor selection process is critical to achieving project delivery; and the benefits of adopting the right process for selecting construction vendor are many. According to Sambasivan and Soon (2007) they include reduction in procurement costs, decreasing project delivery lead time, and enhancing the quality of project delivery. Morlacchi (1999) asserted that deploying the right procedure to selecting construction material vendors leads to increased positive reputation, improving client and user satisfaction, and strengthening the competitiveness and performance of the entire project implementation (Aziz, 2013; Doloi, Iyer, & Sawhney, 2011; Ho, Xu, & Dey, 2010; Sambasivan & Soon, 2007). Many authors have carried out studies directed at the process of selecting vendors in construction industry. For instance, in the study of the Ireland construction industry, Ho et al. (2010) reported that the vendor selection process in construction industry has shifted from the traditional technical and operational function to a more strategic role. In a similar study, Morlacchi (1999) suggests the technical team that evaluates and selects construction material vendor ought to cut across various organizational functions like Accounting, Operations, Procurement, Marketing, IT in order to enhance competitive advantage.

Weele and Van (2014) identified a-four step construction vendor section process which include beginning with subcontracting, through prequalification of potential suppliers, request for quotation and bid analysis, to the selection proper. Munya (2012) advised that the ultimate choice of the selected supplier should not merely consider the price of say goods and services but also incorporate the total costs involved. Doloi et al. (2011) advocated the adoption of ccompetitive vendor selection process capable of achieving procurement efficiency thereby increasing its performance. Lysons and Farrington (2016) found that the vendor selection process typically involves the following phases namely: identify or re-evaluate needs; define or evaluate users' requirements; decide to make or buy; identify type of purchase; conduct market analysis; identify possible suppliers; pre-screen possible suppliers; evaluate the remaining supplier base; choose supplier; deliver product/service; post purchase/ make performance evaluation. These stages have great similarity with the selection procedure in Nigeria.

Munya (2012) observed that in order for selection process to work as an advantage to construction organizations, it must have the following competitive elements or initiatives: tendering, bidding, supplier analysis, and supplier firm collaboration. According to Ogot, Nyang'aya, and Muriuki (2018), these initiatives work best at ensuring the best supplier is selected which in return help improve the supply chain performance. It is important however to note that supplier selection process need to take into account crucial principles if at all the organization is to derive improved procurement performance from this exercise.

Construction supply chain management

Managing supply chain in the construction industry has received profound interest amongst scholars, researchers and construction project stakeholders (Eriksson, 2010; Nguyen et al., 2018; Segerstedt & Olofsson, 2010; Vrijhoef & Koskela, 2000). To ensure that the right supplier is selected, understanding the characteristics that defines the construction supply chain is important. To start with, Behera, Mohanty, and Prakash (2015) described construction supply chain as entailing all activities that enhance the flow of material and components, information, labour and funds through various supply chain echelons to ensure that projects are delivered at the predetermined time range, without costs overrun, and at user satisfaction. Kamaruddeen, Hui, and John (2019) argued that the complexity and temporal nature of construction project makes the efficient application of supply chain management processes such as the use of strategic supplier partnership, collaboration, just-in-time capability, postponement, and supply chain integration somewhat difficult. Safa et al. (2014) contended that effective supplier selection in construction supply chain is limited by factors such as complexity due to many actors, discontinuity of demand for project, and uniqueness of projects in financial, technical and socioeconomic dimensions. In a Vietnam construction industry study conducted by Nguyen et al. (2018) application of supply chain management in construction was found to be limited by issues related to capability, awareness, support systems, collaborative relationship, supply chain innovation, and information technology application. Al-Werikat (2017) identified some characteristics of construction supply chain including partial supply chain relationship amongst client, contractors, and suppliers; complexity due to many actors (subcontractors and suppliers); fragmented supply chain structure, temporary/short term partnership and make-to-order. Vrijhoef (2011), had earlier argued that the fragmentation in construction supply chain is due to the numerous players in the construction space as well as the temporal nature of construction projects.

Vendor selection criteria in Nigeria

In order to effectively adopt the supplier selection process in Nigerian construction industry, it is important to identify a set of criteria. There seems to be a consensus in the literature on the qualitative criteria for selecting a vendor. Kamaruddeen et al. (2019) noted that there are massive benefits to the buyer when the vendor is fully aware of what selection factors are important to the buyer since it helps them customize their strategy to meet the buyers' needs. Akande et al. (2018) identified a set of generic determinants that are important during supplier selection regardless of the industry the firm subscribes to. Aibinu and Odeyinka (2006) suggested that supplier quality is an important selection determinant. The author described quality in relation to durability and ultimate products lifespan. Odeyemi et al. (2019) viewed supplier quality in terms of simplicity and flexibility of operation. In Anyona (2011), supplier warranties constitute an important section criteria and a way of extending service to the buyer.

According to Adebowale and Ayodeji (2015) the provision of technical support, and product customization also important in selecting a construction vendor supplier. Moreover, Mwikali and Kavale (2012) adds that a vendor with shorter lead time, timely delivery and ease of communication channels is better placed to work with. When choosing a supplier, issues like ISO 9000 accreditation, supplier innovation and technological levels need to be ascertained (Shahadat, 2003). Munya (2012) pointed out that the supplier's geographical location, capabilities, and facilities need to be checked before their selection as this has great impact on whether or not they can deliver thus wading off unwarranted delays. Toor and Ogunlana (2010) found that vendor performance indicators such as safety, efficient use of resources, stakeholder satisfaction, and reduced conflicts and disputes were increasingly become important amongst construction stakeholders.

METHODOLOGY

The study was focused on ongoing public construction projects because of their relatively high concentration in metropolitan towns compared to rural communities. The cross sectional survey design on the basis of quantitative research approach was adopted in this study. This was considered appropriate because of its economy; which enables the selection of representative unit of the larger population through sampling process, and collecting data from the population sample, within at a single point in time, over a short period of time (Hunger & Wheelen, 2012). In addition, choosing the cross-sectional survey was deemed appropriate because it allowed the researcher to collect relevant data about the specific vendor selection practice adopted by construction project managers in the study area, without necessarily manipulating the study variables or population characteristics of study participants (Halldórsson & Arlbjørn, 2005). Besides, many extant studies relating to construction vendor selection appears to adopt more of the cross-sectional survey and quantitative approaches than other methods (Fayezi, Zomorrodi, & Bals, 2018; Miemczyk, Johnsen, & Macquet, 2012; Sambasivan & Soon, 2007).

A sample of 71 project managers in the procurement, stores, warehousing, and survey units of the 107 registered construction contractors were randomly chosen for this study. The Krejcie & Morgan's (1970) sample size determination technique was deployed for that purpose. In line with (Christou, 2012; Creswell & Clark, 2010), the choice of random sampling, a probabilistic sampling approach was to avoid prejudice and ensure fairness in selecting participants into the study. A structured, closed-ended, questionnaire was developed by the researcher and used for the collection of primary data. A thorough literature review, in conjunction with informal discussions with on-site project managers enhanced the development of the initial questionnaire (Kamaruddeen et al., 2019; Kant & Dalvi, 2017; Lambert, Adams, & Emmelhainz, 1997). The survey was designed using the five-point Likert-scale where 1 represents "not important," 2 represents "moderately important", 3 represents "strongly important" 4 indicates "very strongly important", and 5 implies "extremely important"

In order to ensure the instrument generates quality research outcomes, a pilot survey was carried out with two academic experts and four project management practitioners followed by personal telephone conversations with the same individuals. This resulted in few modifications of the initial items in the questionnaire. Some items were deleted either due to their lack of clarity or their likely irrelevance to the Nigerian construction industry. Few items were also

combined for better understanding of the participants. And some additional items were included as per recommendations received during the pilot phase. As a result of this exercise, a list of 26 vendor selection criteria was included in the final version of the questionnaire. At a later stage of this study, Cronbach's reliability analysis was calculated in order to check the internal consistency of the selection criteria included in the questionnaire. As shown in Table 3, the overall average reliability of scale items was found to be α =0.814. According to Nunnally and Bernstein (1994), reliability threshold of 0.7 is an indication that an instrument is good enough and so confirmed the internal reliability of the items included in the questionnaire.

Data gathered from field survey were subjected to descriptive statistics such as Mean Score (M), Standard deviation (SD), and Relative Importance Index (RII). The mean and standard deviation were used to aid the identification of the specific supplier selection criteria employed by construction industry professionals through a check-list of criteria provided. To mathematically determine the extent of importance of each vendor selection criteria, the Relative Importance Index (RII) analysis was employed. Relative Importance Index weighs the perception of respondents on any given factor of investigation (Rooshdi et al., 2018). For purpose of decision making, the RII value ranges from 0 to 1, the higher the value of RII, the more important the criteria and vice versa. Thus, the factor with the highest weight is ranked the greatest in importance, while the factor with lowest weight is ranked weakest in importance and so on. The use of RII method is widespread in construction and project management studies. For instance, Rashid et al. (2018) calculated the RII to quantify the factors for construction project delay. Rooshdi et al. (2018) also adopted the same method to rank the sustainable design criteria for highway construction. Since the current research is similar in characteristics and objective with prior studies, a similar method (RII) was suitable.

Relative Importance Index (RII) = $\sum \frac{W}{AxN}$

Where: W= the weight assigned by each respondent on a scale of 1 -5; where 1 is the least & 5 is the highest.
A = the Highest Weight
N = Total number of sample
$\sum$ = summation of individual response

FINDINGS AND DISCUSSION

Results of Respondent's Demographics

A total of 80 copies of the questionnaire was administered on project managers and engineers. Respondents returned 76 copies. However, 71 copies were appropriately filled, and they were used for the purpose of analysis. This translates to an effective response rate of 88.8%. The sample characteristics and demographic profile of respondents are as presented in Table 1. As indicated, 77.1% of the respondents were male while 22.9% were female; indicating the usual dominance of the male engineers in the construction project industry. The results of respondent's age show that majority of the responses (58.4%) came from those between 41-50 years, followed by those between 31-40 years (19.8%), 51years and above (11.9%), in that order respectively. Correspondingly, for the years of experience, 13.9% of the respondents

have less than 5 years of experience, 11.9% have years of experience between 6 to 10, 74.2% of the respondents have 11 years and above experience. Given the years of working experience, it can be inferred that most respondents were experienced professional and knowledgeable enough to make reliable opinions on the subject matter.

Furthermore, respondents were generally well educated as majority (38.6%) holds bachelor degree. Moreover, the respondents who took part in the study were Civil Engineers (48.5%), 23.8% were Project Managers, 7.9% were Construction Managers, while the rest 5.0% were Quantity surveyors. These results are similar to those of previous studies, such as Waris, Khamidi, and Idrus (2014), whose respondents were predominantly project managers, and construction engineers, and that of Rashid et al. (2018), in whose study, about 42% of the respondents were equipment managers and civil engineers. In addition, majority of respondents 65.7% were in procurement-related units, 37.1% were those occupying the positions and performing procurement roles. These analysis implies that the socio-demographic characteristics was widespread and typical of construction project industry.

Table 1: Respondent's demographic profile (N= 71)

Sample characteristics	Components	Per cent %
Gender	Male	77.1
	Female	22.9
Age	Less than 30yrs	12.3
	30-40 yrs	19.8
	41-50yrs	58.4
	51-60yrs	11.9
Size of workforce	Less than 15	11.2
	15-20	23.8
	21-50	54.2
	51-100	10.0
	More than 100	0.8
Highest Qualification	Bachelor Degree	69.9
	Master's Degree	26.0
	Doctorate Degree	4.1
Department	Warehouse & Stores	22.1
	Procurement & logistics	65.7
	IT	8.88
	Project Design	3.32
Job position	Project Manager	23.8
	Quantity Surveyor	5.0
	Construction Manager	7.9
	Civil Engineer	48.5
	Stores Supervisor	12.4
	Others	2.8

Identification of specific supplier selection criteria employed by construction managers

The first research question was concerned with identifying the specific vendor selection criteria used in the construction industry. Respondents were provided with a check-list of 36 criteria, they were asked to indicate the extent to which they specifically considered each criteria when choosing construction material vendors. The mean score of $\geq$ 2.50, derived by dividing the sum of the scale by 4, was used as a cut-off point for assessing the responses and for making decision. Thus, a selection criterion with mean score less than 2.50 is rated low in terms of the

extent to which it is employed for supplier selection. On the other hand, a mean score between 2.50 and above was considered high, implying that such criteria reflect the reason for construction supplier selection. The results on Table 2 summarises the findings regarding what attributes that respondents take into consideration when selecting a construction material vendor.

Table 2: Specific construction vendor selection criteria

Rank the following attributes to reflect your reason for choosing a construction material supplier	Minimum	Maximum	Mean	Std Dev	Mean Ranking
Innovation in use of technology	1.00	5.00	3.4789	.77199	1
Financial position	1.00	4.00	3.4732	.75166	2
Availability of technical support	1.00	4.00	3.3239	.75166	3
Registration with relevant authorities	1.00	4.00	3.3238	.80990	4
Tendered cost (Price)	1.00	5.00	3.3000	.80990	5
Quality certification-ISO 9000	1.00	4.00	3.2776	.76431	6
Rejection rate of supplies at inspection	1.00	4.00	3.2677	.73515	7
Flexible operation when resolving delays	1.00	5.00	3.2114	.73515	9
Responsiveness to warrantee issues	1.00	5.00	3.2113	.74277	8
Geographical location	1.00	4.00	3.1831	.59305	10
Technical capacity	1.00	4.00	3.1830	.74692	11
Demand flexibility	1.00	5.00	3.1408	.74250	12
Minimum number of defective products	1.00	5.00	3.1407	.74250	13
Quality of materials delivered	1.00	4.00	3.1406	.61634	14
Ease of payment terms	1.00	4.00	3.1405	.81584	15
Clear understanding of clients objectives	1.00	4.00	3.1404	.81584	16
Flexible delivery time	1.00	4.00	3.1268	.63086	17
Industry reputation	1.00	4.00	3.1267	.84396	18
Discount for bulk order and early payment	2.00	4.00	3.0845	.62670	19
Tax clearance certificate	2.00	4.00	3.0844	.62670	20
Internal quality assurance and audit system	1.00	5.00	2.9718	.43186	21
Age of the firm	1.00	5.00	2.9577	1.1641	22
Qualification of human resources	1.00	5.00	2.9576	.30696	23
Accuracy in documentation	2.00	4.00	2.6901	.90696	24
Past records of CSR	1.00	4.00	2.6000	.98561	25
Safety of delivery trucks & other logistics equipment	1.00	4.00	2.5169	.71714	26
Past records of dispute settlement	2.00	4.00	2.2901	.61064	27
Relationship with local Community	1.00	5.00	2.2718	.82759	28
Environmental friendly packaging	1.00	5.00	2.2324	.82759	29
Productivity improvement awareness	1.00	4.00	2.1549	.83558	30
Proactiveness (Ability to deal with unanticipated problems)	1.00	4.00	2.0845	.83558	31
Past working relationship with clients	1.00	4.00	2.0423	.82686	32
Ethical sensitivity of delivery staff	1.00	4.00	2.0141	.79839	33
Records of employees health and safety	1.00	4.00	2.0000	.86119	34
Health safety environment (HSE) records	1.00	4.00	1.8423	1.2022	35
Transport route flexibility	1.00	4.00	1.0141	.80313	36

Based on the benchmark mean score of 2.5, ten (10) of the 36 construction vendor selection criteria had their mean value less than the acceptable decision threshold and were removed from further analysis. The result implies that respondents were familiar with the remaining 26 criteria as used for evaluating construction materials vendors in the study area. Adopting the Analytic Hierarchy Process (AHP) approach (Suraraksa & Shin, 2019), the remaining 26 construction vendor selection criteria were grouped into five main dimensions by their characteristics (Quality, Costs, Capacity, Flexibility, and Sustainability) as shown in Table 3.

Table 3: Dimension and ranking of construction vendor selection criteria

Dimension	Cronbach(α)	S/N	Selection criteria	Mean weight	Item Rank
Quality	**0.87**	1.	Rejection rate of supplies at inspection	3.27	7
		2	Quality certification-ISO 9000	3.28	6
		3	Tax clearance certificate	3.08	19
		4	No of defective products	3.14	12
		5	Quality of materials delivered	3.14	13
		6	Internal quality assurance and audit system	2.79	23
		7	Accuracy of documentation	2.69	24
Costs	**0.78**	8	Ease of payment terms	3.14	14
		9	Discount for bulk order and early payment	3.08	20
		10	Tendered cost (Price)	3.30	5
		11	Financial position	3.47	2
Capacity	**0.73**	12	Innovation in use of technology	3.48	1
		13	Availability of technical support	3.32	3
		14	Regulatory and professional registration	3.32	4
		15	Geographical location	3.18	11
		16	Technical capacity	3.19	10
		17	Clients objective clarity	3.14	15
		18	Industry reputation	3.13	17
		19	Age of the firm	2.96	22
		20	Qualification of human resources	2.97	21
Flexibility	**0.81**	21	Flexible operation when resolving delays	3.21	9
		22	Responsiveness to warrantee issues	3.22	8
		23	Demand flexibility	3.14	16
		24	Flexible delivery time	3.13	18
Sustainability	**0.75**	25	Past records of CSR	2.60	25
		26	Safety of delivery trucks & other logistics equipment	2.52	26

Results in Table 3 shows the 26 identified vendor selection criteria. The 26 vendor selection criteria are also classified accordingly into five dimensional parameters, namely: Quality, Costs, Capacity, Flexibility, and Sustainability.

Relative Importance Analysis Construction Project Suppliers Selection Criteria

The determination of the importance placed by construction project managers on the identified supplier selection criteria was achieved through the calculation and analysis of relative importance index (RII). Table 4 shows the importance of each criteria for the selection of construction materials vendors as perceived by respondents. As indicated, the RII is determined for each dimension and for the overall criteria for comparison purpose. The level of importance for each selection criteria is defined in line with Akadiri (2011) in the following scales: 0.1 - 0.19= Very low (VL), 0.20 - 0.39= Low (L), 0.40 - 0.59= Medium (M), 0.6 -0.79 = High (H) and 0.8 -1 and above =Very High (VH).

Overall, result reveals that the RII ratings ranges from 1.10 for “Innovation in use of technology” to 0.22 for “Responsiveness to warrantee issues.” Results also depicts the RII in the following descending order of priority: supplier capacity (RII= 0.74), supplier quality (RII= 0.73), cost factors (RII= 0.72), supplier sustainability (RII= 0.55), and supplier flexibility (RII= 0.28). Thus, on the average, supplier capacity dimension was considered most important for

the selection of construction industry material vendors. This results clearly shows the importance respondents attach to capacity-related criteria for the selection of construction material vendors. For instance, eight of the criteria (technology innovation, technical support, statutory registration, location, clients' objective clarity, industry reputation, firm age and qualification of internal human resources) relate directly to supplier capacity dimension. Indeed, most of the supplier capability-related criteria emerges either as "very highly (VH)" or "highly (H)" important decision variables.

From the RII ranking of selection criteria, it has also been found (Table 4) that seven of the 26 criteria were ranked very highly important, eight were ranked as very high, another seven ranked moderately important, and four ranked as lowly important. On the other hand, the least important dimension was supplier flexibility in terms of flexibility in resolving supply delays, responsiveness to warrantees, demand flexibility, and flexible delivery time. In totality, the most important criteria for supplier selection in the construction industry relates to technological innovation (RII= 1.10) which is a supplier capability criterion. This is followed by ease of payment terms (RII= 1.06) which is a very important criterion in the costs dimension of supplier selection, availability of technical support (RII= 1.05), quality of material delivery (R=1.02) and less number of defective product (R=0.81) in that order respectively.

Table 4: Priority ranking by relative importance of supplier selection criteria

Selection Dimension	No	Selection Criteria	RII of Criteria	Relative Ranking of Criteria	RII of Selection Dimension	Relative Ranking of Selection Dimension	Level of Criteria Importance
Quality	1	Rejection rate of supplies at inspection	0.71	11			H
	2	Quality certification-ISO 9000	0.67	12			H
	3	Tax clearance certificate	0.65	13			H
	4	No of defective products	0.81	5	0.73	**2nd**	VH
	5	Quality of materials delivered	1.02	4			VH
	6	Internal quality assurance and audit system	0.72	10			H
	7	Accuracy of documentation	0.52	19			M
Costs	8	Ease of payment terms	1.06	2			VH
	9	Discount for bulk order and early payment	0.64	14			H
	10	Tendered cost (Price)	0.41	22	0.72	**3rd**	M
	11	Financial position	0.81	6			VH
Capacity	12	Innovation in use of technology	1.10	1			VH
	13	Availability of technical support	1.05	3			VH
	14	Regulatory and professional registration	0.45	21			M
	15	Geographical location	0.55	18	0.74	1st	M
	16	Technical capacity	0.81	7			VH
	17	Clients objective clarity	0.56	17			M
	18	Industry reputation	0.75	9			H
	19	Age of the firm	0.79	8			H
	20	Qualification of human resources	0.62	15			H
Flexibility	21	Flexible operation when resolving delays	0.31	24	0.28	**5th**	L
	22	Responsiveness to warrantee issues	0.22	26			L
	23	Demand flexibility	0.24	25			L
	24	Flexible delivery time	0.33	23			L
Sustainability	25	Past records of CSR	0.50	20	0.55	**4th**	M
	26	Safety of delivery trucks & other logistics equipment	0.59	16			M

Discussion and Implication of Findings

Selecting the right material vendors is crucial for successful implementation of infrastructure project including construction. Thus, the thrust of this study was two-folds; identifying the specific supplier selection criteria used by construction project managers; and prioritizing their importance for construction project managers. In the first instance, findings showed that 26 vendor selection criteria were identified as commonly used amongst the respondents including innovation in use of technology, financial position, technical support, regulatory & professional registration, tendered cost, quality certification, low product rejection rate, responsiveness to warrantee issues, flexible operation when resolving delays, and technical capacity amongst others.

Past studies have also confirmed the deployment of some of these criteria for selecting construction material vendors. For instance, Benton and McHenry (2010) found the most critical criteria for supplier selection in the Mexican construction industry to include quality certification, delivery dependability, and quoted price. The current finding is also consistent with Ting and Cho (2008) which found delivery quality, product quality, technical capacity, financial standing amongst the most important vendor selection attributes in Taiwanese high tech construction industry.

The consistency between the current study and prior investigation also extend to two recent works: Eshtehardian, Ghodousi, and Bejanpour (2013) for instance identified about 23 criteria for selecting a supplier of building materials in Iran. According to the authors, five most important criteria mentioned by respondents were quality, on-time delivery, the minimum number of defects, ability to meet large orders and fast delivery. Similarly, Plebankiewicz (2010) in a study of Netherland civil construction works found supplier's past experience; industry reputation, geographical location; quotation price, financial situation, delivery capacity and guarantees and conditions of payment as major supplier selection attributes. Except in very few prior studies, it is possible to observe some form of uniformity between extant literature and the current findings in the usage of specific criteria for selecting suppliers in construction project industry. The implication of these findings is that the project construction industry is generally becoming more receptive to the use of multiple criteria for supply chain vendor selection.

In terms of the relative importance of each criterion, this study has shown that construction project managers attached foremost importance on capacity-related selection criteria such as being innovative in the use of technology, providing technical support, having good reputation in the construction supplies industry, operating age of the supplier; which symbolises experience, and the qualification of internal human resources. Respondents also rated highly the supplier quality criteria. The findings corroborate Suraraksa and Shin (2019) which, in a study of Thailand's civil engineering works found supplier quality as the most important selection dimension in terms of product quality, delivery quality, documentation quality, low order defect rate, ISO 9001 implementation, quality assurance certification, and level of investment in quality improvement. By implication, the findings seem to suggest that construction industry prefer suppliers with low rejection rate of supplies at materials inspection, quality related certifications such as ISO 9000, having up-to date tax clearance, less defective products, and internal quality assurance systems. On the other hand, the finding in the current study differ with that of Akande et al. (2018) which, in a study of the relative importance of

supplier selection criteria as perceived by 127 Malaysian construction industry professionals showed that track performance, financial capacity and quotation costs were the most important selection criteria. In addition, a contradiction can be observed between the findings in the current study and that of Ho, Nguyen, and Shu (2007) which, through an in-depth interview of 22 specialists in Taiwan and Vietnam civil construction and engineering industry reported the three most important supplier criteria as price, flexible delivery, and number of past construction projects involvement.

Two of the costs-related selection criteria also received relatively high important ratings in this study. In particular, ease of payment terms, provision of discount for bulk purchase and early payment were amongst the top-rated important criteria. However, quotation costs (i.e tender price) received moderate important rating from construction industry project managers. Similarly, this finding gained supports in existing studies such as McCord et al. (2015), and Lu and Geyao (2010) who, in their respective studies reported that quotation cost or tender price was not rated very highly as a construction vendor selection criterion.

CONCLUSION

By selecting the right material vendor, project success can be enhanced, and the risk of project delay, stakeholder dispute, and budget-overrun can be avoided. This study has provided relevant findings to ensure that Nigerian project managers achieve operational efficiency in construction project through appropriate selection of material vendors. The most important conclusion in this study are: First, the topmost vendor selection criteria in the construction industry includes: innovation in the use of technology, financial capacity, technical support, regulatory & professional registration, tendered cost, quality certification, low product rejection rate, responsiveness to warrantee issues, flexible operation when resolving delays, and technical capacity. Second, the construction industry attaches varying level importance to the aforementioned selection criteria for the purpose of prioritization and decision making. In that regards, criteria such as innovative use of technology, ability to provide technical support, good financial capacity, and positive reputation in the construction supplies market were foremost in priority. Third, supplier capability criterion was found as the most significant determinant of construction performance measured in terms of meeting deadlines, meeting budget, less fatalities, and minimised stakeholder dispute.

Given these conclusion, the study recommends that construction industry regulators such as the Nigerian Society of Engineers (NSE), Council for the Regulation of Engineering (COREN), and Project Management Institute Nigeria (PMIN) etc should ensure that the vendor section criteria found in this study becomes policy initiatives to be implemented and enforced throughout the industry. In addition, in order to reverse the failure narrative in the Nigerian construction industry, industry leaders should assist suppliers to develop capacity to ensure they meet with the selection requirements. This can be done through continuous supplier development and improvement programs.

LIMITATIONS AND AREAS OF FURTHER STUDY

This study has some limitations. First, the use of primary data survey questionnaire alone could impair the study outcome. The findings would probably be different if data collection was supplemented with qualitative approach such as the personal interview. Secondly, due to time constraint, additional inputs were not sought from the construction supply chain managers in the

field to validate responses obtained from the questionnaire. Future studies could consider a mixed research method where both questionnaire and interview would be conducted. Further research could test the findings in this study on other industry to see whether the same results would be obtained. Moreover, we studied developmental infrastructure construction projects domiciled in metropolitan cities alone, whereas vendor selection processes can also be understood from the perspective of social construction projects implemented in the rural community.

REFERENCES

Adebowale, O. J., & Ayodeji, F. J. (2015). Analysis of construction-related factors affecting the efficiency construction labour. *Journal of Construction Project Management and Innovation, 5*(1), 1115-1130. http://hdl.handle.net/11189/4956

Aibinu, A. A., & Odeyinka, H. A. (2006). Construction delays and their causative factors in Nigeria. *Journal of construction engineering and management, 132*(7), 667-677. https://doi.org/10.1061/(ASCE)0733-9364(2006)132:7(667)

Akadiri, O. P. (2011). *Development of a Multi-Criteria Approach for the Selection of Sustainable Materials for Building Projects.* (PhD Thesis). University of Wolverhampton, Wolverhampton, UK. https://core.ac.uk/download/pdf/40027643.pdf

Akande, O. K., Olagunju, R. E., Obiora, O. C., Edem-Nse, Y. G., Lawal, A., Yisa, D., & Kolo, W. (2018). Evaluation of Failures in Public Project Management Practices in Minna, Nigeria. *Journal of Architecture and Construction, 1*(3), 15-24. https://www.sryahwapublications.com/journal-of-architecture-and-construction/pdf/v1-i3/2.pdf

Al-Werikat, G. (2017). Supply chain management in construction revealed. *International Journal of Scientific & Technology Research, 6*(3), 125-132. https://www.ijstr.org/final-print/mar2017/Supply-Chain-Management-In-Construction-Revealed.pdf

Anyona, L. (2011). *Evaluating the Public Procurement and Supplier Selection Bill 2010*. Boombay Publishers, Nairobi- Kenya.

Aziz, R. F. (2013). Factors causing cost variation for constructing wastewater projects in Egypt. *Alexandria Engineering Journal, 52*(1), 51-66. https://doi.org/10.1016/j.aej.2012.11.004

Behera, P., Mohanty, R. P., & Prakash, A. (2015). Understanding construction supply chain management. *Production Planning & Control, 26*(16), 1332-1350. https://doi.org/10.1080/09537287.2015.1045953

Benton, W. C., & McHenry, L. F. (2010). *Construction purchasing and supply chain management*. U.S.A.: Mc Graw-Hill Companies, Inc.

Botlhale, E. (2017). Enhancing public project implementation in Botswana during the NDP 11 period. *Africa's Public Service Delivery and Performance Review, 5*(1), 1-9. https://doi.org/10.4102/apsdpr.v5i1.163

Christou, I. T. (2012). Forecasting. In I. T. Christou (Ed.), *Quantitative Methods in Supply Chain Management: Models and Algorithms* (pp. 139-202). London: Springer London. https://doi.org/10.1007/978-0-85729-766-2_2

Creswell, J. W., & Clark, B. (2010). *Research design: Qualitative, quantitative, and mixed methods approach* (3rd ed.). Los Angeles: Sage Publications, Inc. https://us.sagepub.com/en-us/nam/research-design/book255675

Damoah, I. S., & Kumi, D. K. (2018). Causes of government construction projects failure in an emerging economy: Evidence from Ghana. *International Journal of Managing Projects in Business, 11*(3), 558-582. https://doi.org/10.1108/IJMPB-04-2017-0042

Doloi, H., Iyer, K., & Sawhney, A. (2011). Structural equation model for assessing impacts of contractor's performance on project success. *International journal of project management, 29*(6), 687-695. https://doi.org/10.1016/j.ijproman.2010.05.007

Eja, K. M., & Ramegowda, M. (2020). Government project failure in developing countries: a review with particular reference to Nigeria. *Global Journal of Social Sciences, 19*, 35-47. https://doi.org/10.4314/gjss.v19i1.4

Eriksson, P. E. (2010). Improving construction supply chain collaboration and performance: a lean construction pilot project. *Supply Chain Management: An International Journal, 15*(5), 394-403. https://doi.org/10.1108/13598541011068323

Eshtehardian, E., Ghodousi, P., & Bejanpour, A. (2013). Using ANP and AHP for the supplier selection in the construction and civil engineering companies; Case study of Iranian company. *KSCE Journal of Civil Engineering, 17*, 262-270. https://doi.org/10.1007/s12205-013-1141-z

Fayezi, S., Zomorrodi, M., & Bals, L. (2018). Procurement sustainability tensions: an integrative perspective. *International Journal of Physical Distribution & Logistics Management, 48*(6), 586-609. https://doi.org/10.1108/IJPDLM-01-2017-0013

Halldórsson, Á., & Arlbjørn, J. S. (2005). Research Methodologies in Supply Chain Management — What Do We Know? In H. Kotzab, S. Seuring, M. Müller, & G. Reiner (Eds.), *Research Methodologies in Supply Chain Management: In Collaboration with Magnus Westhaus* (pp. 107-122). Heidelberg: Physica-Verlag HD. https://doi.org/10.1007/3-7908-1636-1_8

Hanachor, M. E. (2012). Community development project abandonment in Nigeria: Causes and effects. *Journal of Education and Practice, 3*(6), 33-36. https://www.iiste.org/Journals/index.php/JEP/article/view/1634

Ho, C., Nguyen, P.-M., & Shu, M. (2007). Supplier evaluation and selection criteria in the construction industry of Taiwan and Vietnam. *Information and Management Sciences, 18*(4), 403-426.

Ho, W., Xu, X., & Dey, P. K. (2010). Multi-criteria decision making approaches for supplier evaluation and selection: A literature review. *European Journal of operational research, 202*(1), 16-24. https://doi.org/10.1016/j.ejor.2009.05.009

Hunger, J. D., & Wheelen, T. L. (2012). *Strategic management and business policy: toward global sustainability*. New Jersey (US): Pearson Education Inc.

Jenner, S. (2015). Why do projects 'fail'and more to the point what can we do about it? The case for disciplined,'fast and frugal'decision-making. *PM World Journal, 4*(3), 1-18. https://pmworldlibrary.net/wp-content/uploads/2015/03/pmwj32-mar2015-Jenner-why-do-projects-fail-Featured-Paper.pdf

Kamaruddeen, A. M., Hui, S. N. T., & John, O. N. (2019). Identification of Contractor Selection Criteria for Construction Projects in the Eastern Region of Malaysia. *Specialty Journal of Architecture and Construction, 5*(4), 81-94. https://sciarena.com/article/identification-of-contractor-selection-criteria-for-construction-projects-in-the-eastern-region-of-malaysia

Kant, R., & Dalvi, M. V. (2017). Development of questionnaire to assess the supplier evaluation criteria and supplier selection benefits. *Benchmarking: An International Journal*, *24*(2), 359-383. https://doi.org/10.1108/BIJ-12-2015-0124

Krejcie, R. V., & Morgan, D. W. (1970). Determining sample size for research activities. *Educational and psychological measurement*, *30*(3), 607-610. https://doi.org/10.1177/001316447003000308

Lambert, D. M., Adams, R. J., & Emmelhainz, M. A. (1997). Supplier selection criteria in the healthcare industry: a comparison of importance and performace. *International Journal of Purchasing and Materials Management*, *33*(4), 16-22. https://doi.org/10.1111/j.1745-493X.1997.tb00021.x

Lu, M., & Geyao, Y. (2010). The Selection of Construction Material Suppliers in Supplier Relationship Management (SRM). In *2010 International Conference of Information Science and Management Engineering* (Vol. 1, pp. 189-192). IEEE. https://doi.org/10.1109/ISME.2010.247

Lysons, K., & Farrington, B. (2016). *Procurement and Supply Chain Management*. UK, Pearson Education. https://www.pearson.com/en-gb/subject-catalog/p/procurement-and-supply-chain-management/P200000004775/9781292317953

McCord, J., McCord, M., Davis, P. T., Haran, M., & Rodgers, W. J. (2015). Understanding delays in housing construction: evidence from Northern Ireland. *Journal of Financial Management of Property and Construction*, *20*(3), 286-319. https://doi.org/10.1108/JFMPC-07-2015-0028

Miemczyk, J., Johnsen, T. E., & Macquet, M. (2012). Sustainable purchasing and supply management: a structured literature review of definitions and measures at the dyad, chain and network levels. *Supply Chain Management: An International Journal*, *17*(5), 478-496. https://doi.org/10.1108/13598541211258564

Morlacchi, P. (1999). Vendor evaluation and selection: the design process and a fuzzy-hierarchical model. In *Proceedings of the 8th IPSERA Conference, Dublin*.

Munya, N. (2012). *Purchasing and Supply Chain Strategy in Modern Organisations*. Lagos, Punmak Pubishers Inc.

Mwikali, R., & Kavale, S. (2012). Factors affecting the selection of optimal suppliers in Procurement Management. *International Journal of Humanities and Social Science*, *2*(1), 75-78. https://www.ijhssnet.com/journals/Vol_2_No_14_Special_Issue_July_2012/23.pdf

National Bureau of Statistics. (2015). https://www.nigerianstat.gov.ng/

Nguyen, P. T., Nguyen, V. N., Pham, L. H., Nguyen, T. A., Nguyen, Q. L. H. T. T., & Huynh, V. D. B. (2018). Application of supply chain management in construction industry. *Advances in Science and Technology. Research Journal*, *12*(2), 11–19. http://dx.doi.org/10.12913/22998624/92112

Nunnally, J. C., & Bernstein, I. H. (1994). The Assessment of Reliability. In *Psychometric Theory* (Vol. 3, pp. 248-292).

Nweze, N. (2016). Failure of public infrastructure projects in Nigeria: Causes, effects and solutions. *Texila International Journal of Management*, *2*(2), 1-11. https://doi.org/10.21522/TIJMG.2015.02.02.Art004

Odeyemi, S. O., Giwa, Z. T., & Abdulwahab, R. (2019). Building collapse in Nigeria (2009-2019), causes and remedies–a review. *USEP: Journal of Science and Engineering Production*, *1*(1), 123-135. https://www.researchgate.net/profile/Odeyemi-Samson-O/publication/334002053

Ogot, M., Nyang'aya, J., & Muriuki, R. (2018). *Characteristics of the in-service vehicle fleet in Kenya*. Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV). https://www.changing-transport.org/wp-content/uploads/Characteristics_of_the_In-Service_vehicle_fleet_in_Kenya.pdf

Plebankiewicz, E. (2010). Construction contractor prequalification from Polish clients' perspective. *Journal of Civil Engineering and Management, 16*(1), 57-64. https://www.tandfonline.com/doi/abs/10.3846/jcem.2010.05

Rashid, I., Ismail, S., Mohamed, Z., & Latif Saleh, A. (2018). Contractor Selection Criteria: a Study on Malaysian Public Construction Projects. *International Journal Of Engineering & Technology, 7*(3.25), 65-70. https://doi.org/10.14419/ijet.v7i3.25.17471

Rooshdi, R. R. R. M., Abd Majid, M. Z., Sahamir, S. R., & Ismail, N. A. A. (2018). Relative Importance Index of Sustainable Design and Construction Activities Criteria for Green Highway. *Chemical Engineering Transactions, 63*, 151-156. https://doi.org/10.3303/CET1863026

Safa, M., Shahi, A., Haas, C. T., & Hipel, K. W. (2014). Supplier selection process in an integrated construction materials management model. *Automation in construction, 48*, 64-73. https://doi.org/10.1016/j.autcon.2014.08.008

Sambasivan, M., & Soon, Y. W. (2007). Causes and effects of delays in Malaysian construction industry. *International journal of project management, 25*(5), 517-526. https://doi.org/10.1016/j.ijproman.2006.11.007

Segerstedt, A., & Olofsson, T. (2010). Supply chains in the construction industry. *Supply Chain Management: An International Journal, 15*(5), 347-353. https://doi.org/10.1108/13598541011068260

Shahadat, K. (2003). Supplier choice criteria of executing agencies in developing countries. *International Journal of Public Sector Management, 16*(4), 261-285. https://doi.org/10.1108/09513550310480033

Solon, O. (2015). *Failed government IT projects waste £100 million of taxpayers' money in just one year*. Mirror. https://www.mirror.co.uk/news/technology-science/technology/failed-government-projects-waste-100-5176871

Somya, Y., & Namratha, M. (2021). *What Makes a Construction Project Fail?* Saviom. https://www.saviom.com/blog/why-construction-projects-fail/

Suraraksa, J., & Shin, K. S. (2019). Comparative analysis of factors for supplier selection and monitoring: The case of the automotive industry in Thailand. *Sustainability, 11*(4), 981. https://doi.org/10.3390/su11040981

Ting, S. C., & Cho, D. I. (2008). An integrated approach for supplier selection and purchasing decisions. *Supply Chain Management: An International Journal, 13*(2), 116-127. https://doi.org/10.1108/13598540810860958

Toor, S.-u.-R., & Ogunlana, S. O. (2010). Beyond the 'iron triangle': Stakeholder perception of key performance indicators (KPIs) for large-scale public sector development projects. *International journal of project management, 28*(3), 228-236. https://doi.org/10.1016/j.ijproman.2009.05.005

Vrijhoef, R. (2011). *Supply chain integration in the building industry: The emergence of integrated and repetitive strategies in a fragmented and project-driven industry*. IOS Press. http://resolver.tudelft.nl/uuid:bc30b618-9b1b-4389-8a19-8a3ece1fea62

Vrijhoef, R., & Koskela, L. (2000). The four roles of supply chain management in construction. *European journal of purchasing & supply management*, *6*(3-4), 169-178. https://doi.org/10.1016/S0969-7012(00)00013-7

Waris, M., Khamidi, M. F., & Idrus, A. (2014). Sustainable Considerations in the Operation of Onsite Construction Equipments and Vehicles: A Malaysian Perspective. In R. Hassan, M. Yusoff, Z. Ismail, N. M. Amin, & M. A. Fadzil (Eds.), *InCIEC 2013* (pp. 837-849). Springer Singapore. https://doi.org/10.1007/978-981-4585-02-6_72

Weele, A. J., & Van, A. (2014). *Purchasing and supply chain management: analysis, strategy, planning and practice*. Andover: Cengage Learning. https://worldcat.org/en/title/868079739

Zuofa, T., & Ochieng, E. G. (2014). Project failure: The way forward and panacea for development. *International journal of business and management*, *9*(11), 59-71. http://dx.doi.org/10.5539/ijbm.v9n11p59